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DATA INSIGHT

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Impact of cultural tightness on vaccination rate

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Abstract

We find that cultural tightness, that is, the level of social punishment for violating norms, is associated with lower vaccination rates against COVID-19 across both states and counties in the United States. This is consistent with individuals in tighter cultures being more likely to base risk management decisions on social norms rather than on advice from experts and leaders. It is also consistent with our documentation of a social norm against COVID-19 vaccination. This implies that when a society depends on individual action to help manage society-wide risks, social norms can influence the degree to which individuals in tighter societies will engage in actions that minimize the overall risk to the society.

1 | INTRODUCTION

The World Economic Forum's, 2021 Global Risk Report lists "infectious diseases," "climate change inaction," "biodiversity loss," "natural resource loss," and "human environmental damage" as the top risks facing the world over the next 10 years (World Economic Forum, 2021). These risks all share a requirement for collective risk management actions from countries, states, communities, and individuals. Understanding how culture affects collective risk management is critical to mitigating these high-impact risks.

One important aspect of culture that affects individual decision-making is cultural tightness (Pelto, 1968). Cultural tightness (looseness) is the strength of punishment and the degree of latitude (permissiveness) for violating social norms. From the perspective of RMI researchers, it can be used in a similar manner as the Hofstede cultural dimensions (Hofstede, 1984) and the Big Five Personality traits (Schmitt et al., 2007) concepts. Although these are very different concepts, they share the fact that they are fundamental cultural characteristic that have strong support in the cross-cultural psychology literature, and have been measured by other researchers for different geographic regions in such a way that it is readily available for testing differences between regions.[1] This paper examines how members of tight and loose cultures differ in how they mitigate COVID-19 risk through vaccinations.

We suggest that cultures will develop norms and risk perceptions for responding to risks such as COVID-19, and these risk perceptions and norms will be more influential in tight cultures than in loose cultures on the decisions of individuals to mitigate the risk. Unlike Gelfand et al. (2021) who suggest that members of tight cultures embrace risk mitigations and will act in knowledgeable ways to reduce infection rates, we theorize that the decision of what the cultural norm becomes will not always depend on the tightness of the culture. Rather, we theorize that the risk management decisions of members of tight cultures will be influenced by a social norm, but the social norm itself (i.e., vaccination or nonvaccination) is exogenous to tightness. Members of loose cultures will make risk management decisions individually, with less concern for what other members are deciding to do. While members of loose societies may base risk management decisions on guidance from influential leaders or recognized experts, members of tight cultures will look to each other in deciding what to do.

COVID-19 vaccinations are an ideal setting to test our theory empirically because (1) the risk exposure is more similar across different geographic regions than most large insurance events, (2) there is a clear social norm outcome that is easily measured, and (3) the social norm itself (nonvaccination) is the opposite of what widely recognized leaders and experts advocate. We utilize vaccination rates as of July 12, 2021, which is well after shortages of the vaccine were over and before the issue became highly politicized.

We find that state-level cultural tightness within the United States is negatively correlated with COVID-19 vaccination rates, both for the United States as a whole and most subpopulations. This means that there is social pressure in a preponderance of US subcultures to refrain from getting vaccinated, which is consistent both with our prior expectations and with anecdotal media evidence. However, we also find that there is no effect of tightness on the vaccination rates of doctors working in nursing homes. This matches our prediction that true expertise should make social pressure a less important factor in decision making.

We present our theory in Section 2. The analysis is in Section 3. Section 4 concludes and discusses the implications for the risk management literature.

2 | THEORY

Risk does not exist by its own virtue, but is ontologically defined in a social context (Rosa et al., 2013; Solberg & Njå, 2012). Thus, any comprehensive understanding of risk management must contemplate the psychosocial influences of how risk is perceived and defined. The theory of cultural cognition (Kahan et al., 2011) proposes that a person's beliefs about the risks they face

[1]Cultural tightness is available at the state (Harrington & Gelfand, 2014) and country (e.g., Uz, 2015) levels from various sources. The Big Five Personality traits are available at the country (e.g., Bartram, 2013; Schmitt et al., 2007) and US state level (Rentfrow et al., 2008). Hofstede's most up-to date measures from his 2013 book update are available at the country level on his research website http://www.geerthofstede.nl/. For some examples of the use of these in economic settings, see Kwok and Tadesse (2006), Aggarwal et al. (2016), Cumming and Zhang (2019), Zhang et al. (2019), and Li and Gelfand (2022).

depend on the cultural worldview they possess. Their culture provides a lens through which risk is perceived. Aspects of risk cognition are influenced by cultural differences such as cultural values, cultural beliefs, and cultural norms (Dietz & Shwom, 2017). Cultural differences affecting risk cognition influence how risk is perceived (Douglas & Wildavsky, 1983; Kleinhesselink & Rosa, 1991), how individuals support or oppose potential actions to combat risks (Dietz et al., 2007; Stern et al., 1999), and ultimately how risks like infectious diseases and climate change are managed in a culture (Schultz et al., 2007; Szekely et al., 2021).

Emile Durkheim, one of the founders of the field of sociology, suggests that interactions between individuals result in the creation of a new synthetic reality that is greater than the sum of its parts. This synthetic reality is called culture, and even though its foundation is through individual interactions, a common culture can be shared by very large numbers of individuals.

There are many aspects to culture. One important aspect of culture that affects individual decision-making is cultural tightness-looseness (Pelto, 1968). Cultural tightness is the strength of punishment and the degree of latitude/permissiveness for violating social norms. Cultural tightness varies across countries as well as across states in the United States (Harrington and Gelfund, 2014). The development of tight cultures is believed to come from historical differences in risks encountered by the culture such as natural disasters, wars, diseases, and other external threats (Gelfand et al., 2011). Such threats created the need for stronger punishment of behavior that deviates from social norms. Thus the historical development of tight cultures implies that tight cultures should be more effective in responding to crises. However, we suggest that this is not always the case: sometimes a tight culture can be a disadvantage in responding to risk if the social norm being enforced leads to higher society-level risk.

We theorize that the collective threat from any society-wide risk will create a desire for some form of coordination to manage the risk (i.e., collective risk management). These risk management efforts can aim to either reduce the exposure to the risk, reduce the frequency of a loss (i.e., loss prevention), or reduce the cost or severity of a loss (i.e., loss reduction) (Rejda & McNamara, 2014, pp. 47–48). Most natural disasters pose a different level of risk exposure to different geographical regions,[2] making it very difficult to determine empirically whether differences in risk management techniques are rooted in differences in regional cultures or in the different risk exposures. Studying the COVID-19 pandemic has the advantage that different geographic regions faced much more similar levels of risk exposure than is common in most disasters, thus making it easier to empirically identify the effect of cultural tightness.

Collective risk management efforts will result in the creation of collective social norms. Individuals in tight societies will be likely to adhere to the social norm. Individuals in tighter societies form denser social networks and are more likely to rely on their social networks for information during times of crisis, as opposed to individuals in looser societies who rely more on the "strength of weak ties" (Liu et al., 2018). Members of loose cultures will make decisions individually, with less concern for what their peers are deciding to do. Less concern for their peers' opinions leaves more room for input from leaders and experts. Leaders with charismatic or team-oriented leadership styles are more effective in looser cultures, while autonomous leaders are more effective in tighter cultures (Aktas et al., 2016). Autonomous leadership refers to leaders who have extreme confidence in themselves and are therefore less likely to listen to outside input (House et al., 2004, 2013), such as the advice of certified experts. Charismatic leadership refers to

[2]For example, when ranking states by the number of acres destroyed by wildfires, the 10th-ranked state experienced 100 times the damage of the 40th-ranked state in 2021 (Wildfires by State, 2021).

leaders who attempt to motivate their followers with transformational or revolutionary language and behaviors (Conger & Kanungo, 1987). Team leadership refers to appearing to care about the welfare of team members and attempting to build a more cohesive group (House et al., 2013). While nonleaders in loose societies may base their decisions on guidance from charismatic leaders or recognized experts who profess to care about their welfare, members of tight cultures who are not leaders (and therefore are not as overly confident in their own abilities as their leaders are) will look to each other in deciding what to do.

Thus, social norms are amplified in tight cultures. However, the selection of which actions become social norms is a process that is not necessarily determined by cultural tightness. It is possible that the social norm could be based on the values of the culture rather than by knowledge of the risk (similar to Ünal et al., 2018). It is also possible that the social norm that is adopted may even increase risk.

2.1 | A social norm against COVID-19 vaccination

A tricky empirical question in many risk environments is: which risk management technique (s) becomes the social norm that is amplified in a tight culture? In the case of COVID-19, we believe that the bulk of the evidence suggests that the social norm was against vaccination in nonelite subcultures in the United States.[3]

This may seem counterintuitive because subcultures of elites were nearly uniformly pro-vaccination. Nearly every recognized leader and immunology expert is pro-vaccination. All 50 governors and all living ex-Presidents have been vaccinated against COVID-19 (Link, 2021). Nearly all mainstream religious leaders are pro-vaccination, with the US Catholic Conference of Bishops even calling COVID-19 vaccination, "an act of love of our neighbor and part of our moral responsibility for the common good (Brumley, 2021; Crary, 2021a, 2021b; Jaradat, 2020)." Yet these are all suggestions from *leaders*. As previously mentioned, leaders have greater influence in loose cultures, while members of tight cultures tend to look more toward each other than their leaders.

However, the attitude among nonelites was strikingly different. Chris Arnade, who writes for *The Guardian*, *The Atlantic*, and other publications as a self-proclaimed chronicler of "back row America," states that, "outside of fancy neighborhoods filled with college grads and post

[3]"Elite" has been used in different ways in the academic literature. Khan (2012) defines elites as "those with vastly disproportionate control over or access to a resource." Other definitions expand membership in the elite to those with political power. Pareto (1935) proposed that some elites can resemble lions (who dominate by force) while others resemble foxes (who dominate by manipulation and persuasion). We prefer to define eliteness as a continuous variable (rather than a status that one either has or lacks). Our broader concept of eliteness is defined not merely in economic or political terms, but also in terms of influence. Thus, we view eliteness as the amount of economic and social influence one has over other people. Thus, eliteness in the United States is more correlated with career success and education than with inherited status (although inherited status and family connections can certainly help one to gain influence). In addition, higher wealth or more elite education confers higher status, and highly visible fields such as government, media, entertainment, education, religion, and corporate management are associated with higher eliteness because even moderate success in those fields gives one access to an attentive audience. In general, someone who is college-educated with a good job is, at least to some extent, elite. However, even an overly broad definition that includes all individuals with bachelors degrees or who live in a household with more than $100,000 in income (which means $50,000 per worker for dual-income households, which are slightly more than half of all households) results in over half of Americans being classified as nonelite. More reasonable restrictions on eliteness (such as employment status or degree quality) would further expand the percentage that is nonelite.

grads....," (i.e., the vast majority of the country), "being unvaccinated... is worn as a badge of honor, a club membership card, among people who have never trusted authority, and see being unvaccinated as a way to take a little control of the situation (Arnade, 2021)." This social norm is supported in anecdotal news stories of members of tight cultures not responding to their own leaders' advice to get vaccinated (Park, 2021), and individuals pleading with health care providers to NOT share their decision to become vaccinated and even going so far as to wear disguises when going to get vaccinated (Grullón Paz, 2021).

Data supports the idea that vaccine acceptance was significantly higher among elites than nonelites. According to an April–May 2021 survey from Carnegie Mellon of 338,226 Facebook users, COVID-19 vaccine hesitancy is much lower in more elite professions such as "computer and mathematical" (7.3% of respondents), "education, training, or library" (9.0%), "legal" (9.9%), and "business and finance operations" (12.4%) than nonelite professions such as "construction and extraction" (45%), "installation, maintenance, and repair" (39.3%), and "farming, fishing, and forestry" (39.1%). There was also a significant difference within job categories that correlated with social status. Within education, vaccine hesitancy was lowest among "Postsecondary teachers" (3.6%) and highest among "Preschool or kindergarten teachers" (14.8%). Within health care, vaccine hesitancy was lowest among "Pharmacists" (6.9%) and highest among "Emergency Medical technicians/paramedics" (25.3%) (King et al., 2021). These findings likely understate the likelihood of vaccine hesitancy. This is because the month-long survey reported that 75.6% of employed 18–64 year-olds were vaccinated, despite data from the Centers for Disease Control (CDC) showing that only 53% of 18–64 year-olds were either fully or partially vaccinated as of the final day of the survey (May 19). However, the same finding is found in more reliable data. CDC data on nursing home workers as of March 2021 showed that 75% of physicians, 57% of nurses, and 46% of aides were vaccinated against COVID-19. Further, aides who lived in nonelite neighborhoods (classified as being in the highest tercile of % racial minorities, % without a high school diploma, % in poverty; or lowest tercile of median income) averaged 7%–8% lower vaccination rates than those who lived in more elite neighborhoods (Lee et al., 2021).

This difference between elites and nonelites began before COVID-19 vaccines were even approved. In a study of health care workers in October-November 2020, COVID-19 vaccine acceptance is significantly higher among Whites (37%) and Asians (44%) than among Blacks (19%) and Hispanics (30%). Acceptance rates are similar between incomes of $30,001–$70,000 (32%); $70,001–$100,000 (28%); and $100,001–$150,000 (33%), but increase to 45% for those making over $150,001. Education levels tell a similar story: those whose highest degree is a bachelor's degree have vaccine acceptance rates (30%) closer to those whose highest degree is high school, associates, or trade school (22%–24%) than to those with professional (51%) or doctoral degrees (49%) (Shekhar et al., 2021).

In sum, there were many strong reasons to get vaccinated against COVID-19. First and foremost, no one (particularly social conservatives) wanted to go back to lockdowns. Second, the vast majority of people do not want to get sick. Third, Americans generally are pro-vaccine, with 99.0% of the population under 2 years old receiving at least one vaccine (Hill et al., 2021). Fourth, there was strong pressure from the elites to do so. Yet despite all these reasons to get vaccinated, and despite near-universal acceptance of vaccination among a large minority (elites), 45% of Americans ages 18–64 were not fully vaccinated for COVID-19 before mandates were introduced. This is easily explained by a cultural norm against COVID-19 vaccination among the nonelites. Because the overwhelming majority of people are nonelites, this means that the average cultural norm was nonvaccination.

Thus, the COVID-19 pandemic is an interesting test case for another reason: the leaders of the United States nearly universally professed a different opinion about the correct risk management technique than the prevailing social norm (outside a fairly small yet widely distributed group who are members of the highly educated class).

3 | ANALYSIS

To test this theory, we gather data on COVID-19 vaccination rates for each county[4] from the CDC's website.[5] We use vaccination rates as of July 12, 2021 because this was the inflection point when vaccinations per day began increasing again. At this point, the vaccine was readily available to anyone who wanted it, yet it had not yet become nearly as highly politicized as it was to become in late August when federal vaccine mandates began to be seriously discussed. In an unreported robustness check, we used different dates from summer 2021 and obtained similar results.

We obtain data on tightness-looseness scores at the state level from Harrington and Gelfand (2014).[6] We obtain data on Big Five personality traits at the state level from Rentfrowet al. (2008).[7] We control for these because these personality traits have been linked to vaccine acceptance (Lin & Wang, 2020). In addition, the Big Five personality traits vary substantially by region and are believed to be measures of cultural regions in a similar manner as tightness, making them a potentially confounding variable. Controlling for Big Five personality traits makes it less likely that we will find any result for tightness on vaccination rates. For all cultural measures, we assign the District of Columbia the same values as Maryland, although results are robust to dropping District of Columbia. Figure 1 displays a simple graph of Tightness versus Vaccination Rates of all residents 12 and older from our data set.

Both tightness and the Big Five personality measures are measures of culture. Schein (1991) notes that "cultural implies stability," because, "in most societies certain phenomena persisted over time and displayed remarkable stability even in the face of pressures toward change." Thus, while it is possible that measures of culture can change over time and add error to the empirical design of this study, in general it is thought that these data variables will remain useful to future researchers for future studies.

We control for each state's vote in the 2020 US Presidential election. Political preferences may be important because while vaccine misinformation and the antivaccine movement in the

[4]The census bureau uses the word "county-equivalents" to refer to government-level organizations that are called counties in most of the country, but in other parts of the country are called parishes, boroughs, or independent cities.

[5]We use vaccination rates and numbers by the age groups they provide (12+, 18+, and 65+) to infer vaccination rates by age group (12–17, 18–64, and 65+). We also use vaccination rates among nursing home staff. Data are from: https://www.cdc.gov/coronavirus/2019-ncov/vaccines/distributing/about-vaccine-data.html and https://data.cms.gov/covid-19/covid-19-nursing-home-data

[6]They use a "composite index of nine items. Four items reflect strength of punishment: (i) the legality of corporal punishment in schools, (ii) the percentage of students hit/punished in schools, (iii) the rate of executions from 1976 to 2011, and (iv) the severity of punishment for violating laws (i.e., selling, using, or possessing marijuana). Two items reflect latitude/permissiveness: (i) access to alcohol (i.e., ratio of dry to total counties per state) and (ii) the legality of same-sex civil unions. Institutions that reinforce moral order and constrain behavior were assessed with two items: (i) state-level religiosity and (ii) percentage of individuals claiming no religious affiliation. The final indicator was the percentage of total population that is foreign." Their paper tests the validity of their measure in many different ways.

[7]Rentfrowet al. (2008) obtained these by issuing the Big Five Inventory test to 619,397 people through an online survey.

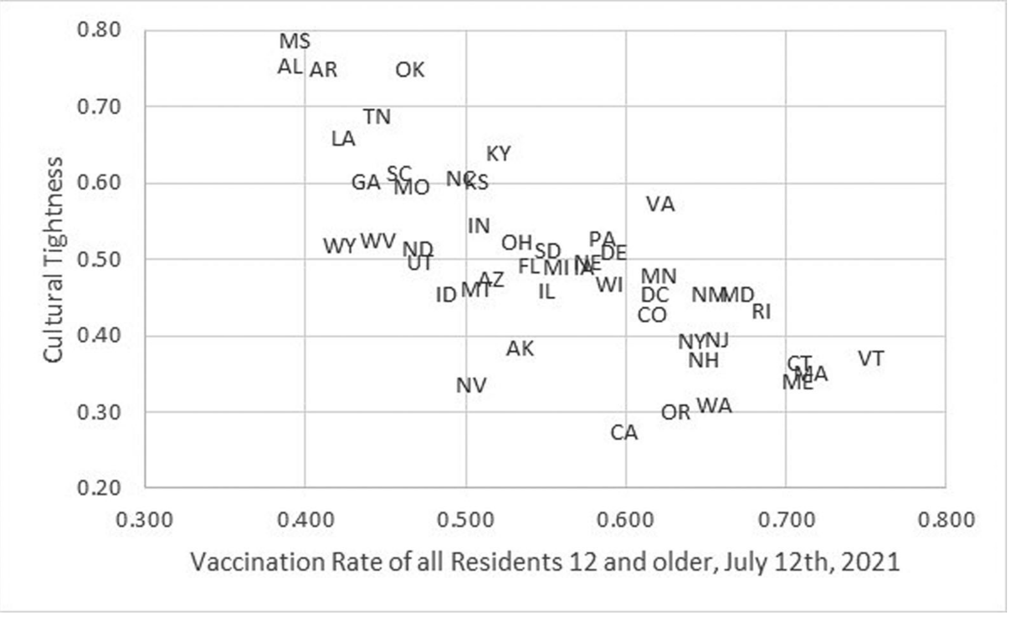

FIGURE 1 Tightness versus vaccination rate. This figure plots cultural tightness (as measured by Harrington and Gelfand, 2014) against the percent of residents age 12 and older who are fully vaccinated against COVID-19 as of July 12, 2021. Each state's dot is indicated using its US postal code. Note that the axes are not at zero so as to allow for increased readability.

United States was concentrated mostly in liberal enclaves in the early 2000s (Berezow, 2014; Conis, 2019; Grzybowksi et al., 2017; Olive et al., 2018; Salmon et al., 2005), and while Republican leaders are generally pro-vaccine, voters for Donald Trump expressed much higher hesitancy towards COVID-19 vaccines than the general public (Hornsey et al., 2020; Kates et al., 2021).

We predict that tightness will be most negatively significant in ages 12–17 (who are subjected to the most peer pressure), negatively significant among adults, and insignificant among nursing home doctors.[8] As stated in the introduction, we predict that it will be insignificant among doctors because doctors' expertise and training reduce the effects of peer pressure. We also test nursing home ancillary service employees and nursing home aides using the same data set to show how doctors compare to nonexperts who are presumably subjected to the same pressure from their employer. We choose to investigate doctors in nursing homes because nursing home workers are the only job, income, or educational data set about which the CDC provides vaccination data at the state level, allowing us to test a group where social pressure should have either a reduced or no effect on vaccination rates.

Table 1 shows summary statistics of the variables we use. In Table 2, we run ordinary least squares (OLS) regressions at the state level. We test the equation:

[8]While parents legally have the right in most cases to make vaccination decisions for their children, in practice older teenagers often have significant influence over their own medical decisions (Angst & Janet, 1996; Vaknin & Zisk-Rony, 2011; Wakimizu et al., 2015)

TABLE 1 Summary statistics

Panel A: Means, standard deviations, and number of observations						
	County equivalents			States + D.C.		
Variable	No. of observations	Mean	Std. dev.	No. of observations	Mean	Std. dev.
Vaccination Rate Age 12–17	2902	15.56	13.93	48	27.75	11.68
Vaccination Rate Age 18–64	2947	36.67	14.84	49	51.98	10.09
Vaccination Rate Age 65+	2947	64.89	19.85	49	79.45	6.82
Vaccination Rate Nursing Home Doctors	0	N/A	N/A	51	77.48	10.48
Vaccination Rate Nursing Home Ancillary Workers	0	N/A	N/A	51	59.53	10.08
Vaccination Rate Nursing Home Aides	0	N/A	N/A	51	49.14	11.8
Tightness	2882	0.543	0.116	51	0.5	0.125
Extraversion	2882	0.172	0.929	51	−0.073	1.007
Agreeableness	2882	0.262	0.873	51	0.034	0.955
Conscientiousness	2882	0.316	0.874	51	0.001	0.999
Neuroticism	2882	0.026	0.933	51	0.016	1
Openness	2882	−0.159	0.809	51	−0.049	0.892
BidenVote	2881	0.341	0.159	51	0.49	0.12
Ln (population)	2839	10.33	1.462	51	15.18	1.043

Panel B: Pairwise Correlation Matrix for State-Level Variables

	Vaccination Rate Age 12–17	Vaccination Rate Age 18–64	Vaccination Rate Age 65+	Vaccination Rate Nursing Home Doctors	Vaccination Rate Nursing Home Ancillary Workers	Vaccination Rate Nursing Home Aides	Tightness	Extraversion	Agreeableness	Conscientiousness	Neuroticism	*h*
Vaccination Rate Age 12–17	**1**											
Vaccination Rate Age 18–64	**0.958**	1										
Vaccination Rate Age 65+	**0.452**	**0.519**	1									
Vaccination Rate Nursing Home Doctors	**0.422**	**0.358**	**0.308**	1								
Vaccination Rate Nursing Home Ancillary Workers	**0.783**	**0.744**	**0.481**	**0.58**	1							

(Continues)

TABLE 1 (Continued)

Panel B: Pairwise Correlation Matrix for State-Level Variables

	Vaccination Rate Age 12–17	Vaccination Rate Age 18–64	Vaccination Rate Age 65+	Vaccination Rate Nursing Home Doctors	Vaccination Rate Nursing Home Ancillary Workers	Vaccination Rate Nursing Home Aides	Tightness	Extraversion	Agreeableness	Conscientiousness	Neuroticism	*h*
Vaccination Rate Nursing Home Aides	**0.801**	**0.78**	**0.435**	**0.522**	**0.908**	1						
Tightness	**−0.764**	**−0.763**	**−0.536**	**−0.398**	**−0.671**	**−0.688**	1					
Extraversion	**−0.352**	**−0.256**	−0.131	**−0.267**	**−0.345**	**−0.276**	**0.274**	1				
Agreeableness	−0.233	−0.206	−0.076	**−0.277**	**−0.272**	**−0.239**	**0.345**	**0.547**	1			
Conscientiousness	**−0.356**	**−0.311**	**−0.291**	**−0.483**	**−0.508**	**−0.407**	**0.403**	**0.43**	**0.673**	1		
Neuroticism	0.073	0.048	0.154	−0.191	−0.071	−0.188	0.199	−0.157	−0.094	**−0.276**	1	
Openness	**0.521**	**0.484**	0.171	−0.074	**0.263**	**0.274**	**−0.372**	**−0.523**	−0.129	0.043	0.138	1
BidenVote	**0.734**	**0.78**	**0.491**	0.164	**0.569**	**0.607**	**−0.572**	**−0.384**	−0.141	−0.231	0.108	**0.532**

Note: Panel A shows summary statistics of the variables used in our regressions at the county level. Vaccination rates are from the CDC. They are displayed as whole percentages, and can vary between 0 and 100. Tightness uses the measure from Harrington and Gelfand (2014), and is divided by 100 for easier viewing of tables. The Big Five personality traits are from Rentfrow et al. (2008). BidenVote is the percentage of the votes that Joe Biden won in the 2020 US Presidential election, and it is from the MIT Election Data and Science Lab. Population is from the 2020 US Census. Panel B shows pairwise correlations of the variables used in state-level regressions. Numbers in bold indicate 10% significance.

TABLE 2 Determinants of state vaccination rates

Dependent Variable is Vaccination Rates among:	Ages 12–17	Ages 18–64	Ages 65+	Nursing Home Doctors	Nursing Home Ancillary Workers	Nursing Home Aides	Ages 12–17	Ages 18-64	Ages 65+	Nursing Home Doctors	Nursing Home Ancillary Workers	Nursing Home Aides
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Tightness	−68.57***	−61.54***	−42.08***	−18.97	−39.02***	−47.43***	−51.18***	−41.30***	−34.35***	−19.87	−28.26**	−29.66**
	(−5.61)	(−5.61)	(−4.44)	(−1.38)	(−3.47)	(−3.49)	(−4.01)	(−4.19)	(−3.35)	(−1.28)	(−2.32)	(−2.10)
Agreeableness	2.56	1.58	2.34*	2.53	3.19**	2.84	1.80	0.67	1.99	2.58	2.54*	1.77
	(1.56)	(1.07)	(1.84)	(1.34)	(2.06)	(1.52)	(1.18)	(0.56)	(1.58)	(1.32)	(1.66)	(0.99)
Extraversion	−1.45	0.01	−1.25	−2.82	−1.39	−0.65	−0.53	0.74	−0.97	−2.85	−0.92	0.13
	(−0.89)	(0.00)	(−1.02)	(−1.54)	(−0.93)	(−0.36)	(−0.35)	(0.63)	(−0.80)	(−1.53)	(−0.63)	(0.08)
Conscien-tiousness	−1.47	−0.82	−0.40	−5.22**	−4.97***	−4.70**	−1.57	−0.74	−0.37	−5.24**	−4.75***	−4.34**
	(−0.81)	(−0.50)	(−0.29)	(−2.46)	(−2.86)	(−2.24)	(−0.94)	(−0.56)	(−0.27)	(−2.43)	(−2.81)	(−2.21)
Neuroticism	1.78	1.64	2.12**	−2.89*	−1.17	−2.40	1.07	0.76	1.79*	−2.86*	−1.55	−3.03**
	(1.43)	(1.46)	(2.19)	(−1.94)	(−0.96)	(−1.64)	(0.91)	(0.81)	(1.85)	(−1.88)	(−1.30)	(−2.19)
Openness	1.77	1.73	−2.01	−2.47	0.98	1.77	0.68	0.05	−2.66*	−2.40	0.17	0.43
	(0.95)	(1.04)	(−1.40)	(−1.19)	(0.58)	(0.87)	(0.39)	(0.04)	(−1.83)	(−1.11)	(0.10)	(0.22)
BidenVote							33.87***	42.08***	16.06*	−1.88	22.39**	36.95***
							(2.90)	(4.77)	(1.75)	(−0.13)	(1.98)	(2.82)
_constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	48	49	49	51	51	51	48	49	49	51	51	51
aic	330.51	327.17	312.81	370.78	350.27	369.62	323.34	307.52	311.27	372.76	347.80	362.95

(Continues)

TABLE 2 (Continued)

Dependent Variable is Vaccination Rates among:	Ages 12–17	Ages 18–64	Ages 65+	Nursing Home Doctors	Nursing Home Ancillary Workers	Nursing Home Aides	Ages 12–17	Ages 18-64	Ages 65+	Nursing Home Doctors	Nursing Home Ancillary Workers	Nursing Home Aides
bic	343.61	340.41	326.06	384.30	363.79	383.14	338.31	322.66	326.41	388.21	363.26	378.41
Adjusted R^2	0.633	0.600	0.346	0.326	0.513	0.480	0.689	0.736	0.377	0.310	0.543	0.551

Note: This table shows OLS regressions at the state-level using Equation (1). Dependent variables are vaccination rates among the group. Vaccination rates are as of July 12, 2021 for columns 1, 2, 3, 7, 8, and 9. Vaccination rates are as of the week ending July 18, 2021 for columns 4, 5, 6, 10, 11, and 12. Variables are defined in the text and data sources are summarized in Table 1. *t*-Statistics are presented in parentheses.

Abbreviation: OLS, ordinary least squares.

*, **, and *** indicate 10%, 5%, and 1% levels of significance, respectively.

$$Vaccination\ \ Rate_{i,j} = \alpha + \beta_1 \times Tightness_j + \beta_2 \times X_{i,j} + \varepsilon_{i,j}, \tag{1}$$

where *Vaccination Rate* is the vaccination rate among the designated population i, within geographic location j, *Tightness* is the cultural tightness measure for geographic location j, and $X_{i,j}$ is a battery of control variables.

The results show that tightness is both statistically and economically significantly negative among ages 12–17, 18–64, and 65+, as well as among aides and ancillary workers in nursing homes. To give an idea of the economic magnitude, the coefficient of −68.57 in regression 5 means that theoretically moving to a state with a one-standard deviation increase in tightness ($\sigma = 0.12486$ from Table 1) is equivalent to an 8.5 pp decrease in vaccination rates (i.e., 8.5% lower vaccination rate) among 12–17 year olds. Results are strongest among younger age groups and insignificant among doctors, consistent with our predictions.

To gain more insights, we investigate Equation (1) using county-level vaccination rates. This allows us to control for local variations in political preferences and population size. We control for county-level population because cultural characteristics may diffuse differently based on the population density of an area. In addition, it is likely that county population may directly impact vaccination rates due to rural Americans' lower desire to get vaccinated (Kirzinger et al., 2021), the traditional lack of government emphasis on vaccination outreach programs in rural areas (Arita et al., 1986; Hardt et al., 2016) and rural areas' lower likelihood of experiencing infection outbreaks (Qin et al., 2019; Wong & Li, 2020; Yoshikura, 2012).

We use state-level cultural measures for each county. While this may introduce some error if cultures are not uniform within a state, in general, the cultural measures used in this study have strong regional correlations that indicate they are at least partially driven by shared regional cultural histories (Krug & Raymond, 1973).

County-level vaccination rates for nursing home workers are not available, so we can not test that at the county level. Texas does not break down vaccination rates by age. Idaho does not give vaccination rates for ages 12–17. We hand-match data for control variables in states (such as Virginia) where some cities have the status of counties. Some control variables for other counties (such as in rural Alaska) are unavailable at the county level, leading to some counties being dropped in some regressions. We obtain county-level voting results from the MIT Election Data and Science Lab. We used Total votes from this data set. However, 10 states do not have total results in the data set yet, so for those states we added up the results for each method of voting (which are included in the data set individually).

Table 3 shows the county-level results. It confirms our main findings from Table 2: tightness has a significant negative impact on vaccination rates in every age group in every regression. The negative result is more statistically significant in younger age groups.

Table 4 shows the county-level results by population size. The purpose of this is two-fold: first, it is useful for robustness purposes to see if the results hold for every subgroup. Second, it is possible that culture may affect vaccination rates in a different way in densely population regions than it does in more rural regions. The results show that in every region, tightness is more statistically significant in determining vaccination rates among lower age groups. In fact, tightness is not statistically significant in vaccination rates of age 65+ in the most lightly populated regions. We speculate that this could be caused by two separate phenomena: either lightly populated regions may not be affected as much by cultural tightness as densely populated regions, or cultural tightness may be higher in big cities than it is in their adjacent cultural hinterlands that share other cultural characteristics.

TABLE 3 Determinants of county vaccination rates

Dependent Variable is Vaccination Rate among ages:	**12–17**	**18–64**	**65+**	**12–17**	**18–64**	**65+**	**12–17**	**18-64**	**65+**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Tightness	−62.89***	−72.65***	−82.26***	−50.90***	−62.39***	−76.62***	−49.77***	−61.20***	−74.59***
	(−7.85)	(−5.14)	(−3.22)	(−5.54)	(−3.78)	(−2.76)	(−5.74)	(−3.88)	(−2.86)
Agreeableness	−1.89*	−3.55	−7.21*	−1.49	−3.43	−7.15*	−1.42	−3.40	−7.10*
	(−1.82)	(−1.61)	(−1.85)	(−1.43)	(−1.51)	(−1.80)	(−1.34)	(−1.52)	(−1.85)
Extraversion	1.50	4.18**	10.00***	−0.10	2.62	9.15***	−0.18	2.20	8.20**
	(0.88)	(2.23)	(3.38)	(−0.07)	(1.31)	(2.81)	(−0.13)	(1.10)	(2.57)
Conscientiousness	−0.81	−1.25	−1.75	0.63	0.17	−0.97	0.77	0.34	−0.70
	(−0.51)	(−0.78)	(−0.64)	(0.56)	(0.11)	(−0.35)	(0.64)	(0.22)	(−0.26)
Neuroticism	1.89*	2.49	5.35	1.42*	2.01	5.08	0.82	1.26	3.76
	(1.83)	(1.33)	(1.59)	(1.73)	(1.21)	(1.52)	(1.08)	(0.82)	(1.21)
Openness	−0.44	−4.20*	−10.18**	−2.25**	−6.11**	−11.23**	−2.79**	−6.90***	−12.69***
	(−0.37)	(−1.74)	(−2.22)	(−1.99)	(−2.51)	(−2.46)	(−2.41)	(−2.75)	(−2.77)
BidenVote				43.00***	39.99***	21.90***	33.26***	29.46***	4.10
				(7.11)	(6.33)	(2.63)	(4.99)	(4.11)	(0.44)
Ln (population)							2.21***	2.40***	4.06***
							(5.41)	(4.31)	(4.64)
_constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2797	2841	2841	2796	2840	2840	2793	2837	2837
aic	21,205	22,413	24,276	19,992	21,688	24,170	19,622	21,473	23,919

TABLE 3 (Continued)

Dependent Variable is Vaccination Rate among ages:	12–17	18–64	65+	12–17	18–64	65+	12–17	18-64	65+
bic	21,247	22,455	24,318	20,039	21,736	24,218	19,676	21,526	23,972
Adjusted R^2	0.298	0.249	0.233	0.544	0.417	0.260	0.590	0.454	0.317

Note: This table shows OLS regressions at the county-level using Equation (1). Dependent variables are vaccination rates among the group as of July 12, 2021. Variables are defined in the text and data sources are summarized in Table 1. *t*-Statistics based on robust standard errors clustered by state are presented in parentheses.

Abbreviation: OLS, ordinary least squares.

*, **, and *** indicate 10%, 5%, and 1% levels of significance, respectively.

TABLE 4 Determinants of county-level vaccination rates, by county population size

Sample:	Counties under 10,000 population			Counties with population between 10,000 and 100,000			Counties with population between 100,000 and 500,000			Counties over 500,000 population		
Dependent Variable is Vaccination Rate among ages:	12–17	18–64	65+	12–17	18–64	65+	12–17	18–64	65+	12--17	18--64	65+
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Tightness	−44.60***	−41.56**	−45.21	−48.83***	−62.29***	−80.09***	−61.15***	−74.28***	−91.03***	−48.68***	−44.03**	−59.74***
	(−4.17)	(−2.44)	(−1.60)	(−5.84)	(−3.93)	(−2.87)	(−4.46)	(−4.10)	(−3.75)	(−2.95)	(−2.25)	(−2.58)
Agreeableness	−3.39**	−7.06**	−13.58***	−1.04	−4.02*	−7.74*	−2.33*	−2.80	−5.24*	−2.33	−2.33	−7.12***
	(−2.07)	(−2.18)	(−2.59)	(−1.04)	(−1.70)	(−1.72)	(−1.81)	(−1.33)	(−1.71)	(−1.40)	(−1.18)	(−2.74)
Extraversion	2.30	4.61*	9.37**	−0.07	3.36	10.23***	−1.16	1.24	5.73**	−1.44	1.92	7.34***
	(1.48)	(1.86)	(2.14)	(−0.05)	(1.54)	(2.74)	(−0.56)	(0.53)	(2.17)	(−0.92)	(1.21)	(3.40)
Conscien-tiousness	1.76	1.88	1.04	0.60	0.19	−1.55	0.46	0.10	1.58	−1.33	−2.03	1.80
	(1.24)	(0.75)	(0.23)	(0.50)	(0.12)	(−0.54)	(0.31)	(0.07)	(0.92)	(−0.67)	(−1.59)	(0.73)
Neuroticism	0.47	−1.10	0.53	0.94	1.19	3.63	1.64	3.77**	7.32***	−0.80	2.32*	7.44***
	(0.54)	(−0.88)	(0.15)	(1.14)	(0.72)	(1.01)	(1.38)	(2.49)	(3.31)	(−0.56)	(1.82)	(3.09)
Openness	−2.49*	−7.23**	−15.07***	−2.59**	−7.66***	−13.72***	−5.40***	−7.33**	−11.88***	−4.81**	−3.64	−10.05***
	(−1.74)	(−2.23)	(−2.68)	(−2.23)	(−3.09)	(−2.86)	(−2.72)	(−2.43)	(−2.69)	(−2.44)	(−1.62)	(−2.65)
BidenVote	30.67***	29.12***	10.19	32.30***	30.01***	9.16	41.71***	25.27***	−2.13	37.91**	23.74*	−12.04
	(3.99)	(3.32)	(0.86)	(4.02)	(3.70)	(0.83)	(5.18)	(3.08)	(−0.24)	(2.04)	(1.74)	(−0.99)
_constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	586	601	601	1658	2034	2034	423	427	427	129	129	129

TABLE 4 (Continued)

Sample:	Counties under 10,000 population			Counties with population between 10,000 and 100,000			Counties with population between 100,000 and 500,000			Counties over 500,000 population		
aic	3954	4579	5162	11,626	15,444	17,365	3048	3158	3374	1006	922	945
bic	3989	4615	5197	11,669	15,488	17,410	3081	3190	3406	1029	945	968
Adjusted R^2	0.351	0.212	0.215	0.440	0.351	0.280	0.527	0.431	0.315	0.347	0.397	0.332

Note: This table shows OLS regressions at the county-level using Equation (1). Dependent variables are vaccination rates among the group as of July 12, 2021. Variables are defined in the text and data sources are summarized in Table 1. Counties are divided into subgroups by population. Populations are from the 2020 US Census. *t*-Statistics based on robust standard errors clustered by state are presented in parentheses

Abbreviation: OLS, ordinary least squares.

*, **, and *** indicate 10%, 5%, and 1% levels of significance, respectively.

In addition, personality differences are more important in older age cohorts across most regressions. This is particularly true in the trait of Agreeableness. This supports Lin and Wang (2020), who find that personality matters to vaccination rates; however, we do not draw a robust conclusion about this.

4 | CONCLUSION

Pandemics are frequently excluded from most types of property/casualty insurance coverage. A pandemic is a systemic risk that is hard to quantify actuarially and potentially extremely large, and therefore it is often considered uninsurable for most types of insurance. However, health insurance by its very nature can not exclude medical treatment of a pandemic. Similarly, the effects of large pandemics on mortality rates can alter life insurance profitability in ways that are ex ante unpredictable (Carannante et al., 2022). Thus, a pandemic is of particular interest to insurance markets because it is a potentially uninsurable risk that is partially covered by insurance.

It is interesting to note that the AIDS pandemic shared two large features with the COVID-19 pandemic: a tendency toward listening to community members rather than experts or leaders when deciding what risk management techniques to undertake, and a tendency toward denial of the risk (Halkitis et al., 2014; Katz et al., 2013; Okunola et al., 2018). The former is completely consistent with our theory. Regarding the latter, although we do not analyze this link directly and we do not believe the social norm of denial is caused by cultural tightness, our theory suggests that it is possible that widespread denial of a new risk may be more likely to take hold in tight societies.

This paper presents evidence that a society's culture tightness can affect the actions that individuals take to mitigate large societal risks. We show that the cultural norm that is reinforced by cultural tightness can be an action (or in this case, an inaction) that increases society's exposure to risk.

The concept of culture influencing reactions is not new within the health care or environmental literature. However, there are several aspects that make this paper unique. First, we look at the impact of cultural tightness on a specific loss prevention/loss reduction activity. Second, we identify this empirically in a setting where risk exposure is relatively equal across geographic regions (the COVID-19 crisis), making it more straightforward to identify the effect empirically. Third, we look at a case where the apparent social norm is starkly different from expert opinion. Fourth, we lay out a theory that explains the outcomes from a risk management perspective, and this theory is more nuanced than previous attempts to look at responses to the COVID-19 crisis. Specifically, our theory allows for the possibility that the social norm is widely regarded by experts as being a harmful risk management technique.

We hope that this paper can lead to more research on leadership techniques and other methods that can improve risk responses in different cultures. However, we urge extreme caution in any attempts to manipulate social norms. Practical efforts in this area have met with mixed results, and even interventions with positive results tended to be less effective in the United States (Rhodes et al., 2020). Our personal observation is that the American public is suspicious of attempts to manipulate social norms, and that these attempts often backfire. However, this does not mean that it is impossible to influence social norms. There is a large literature on efforts to change behaviors by norm-based interventions that the insurance industry can consider (e.g., Miller & Prentice, 2016; Rhodes et al., 2020; Shulman et al., 2017).[9] In addition, it may not always be desirable to change a norm, as norms can often reduce overall risk. For example, a cultural norm of volunteering for nonprofits can reduce insurable damages during a natural disaster, and a positive norm like this will be reinforced more strongly in tighter cultures.

Further, norms are important for insurance professionals to understand even if they aren't attempting to change behaviors. Cultural norms affect product design, marketing, and ultimately take-up rate. This is especially true of insurance products like flood insurance, crop insurance, wind plans, and health and wellness programs that require community participation to respond to risk.

For example, insurers and employers introducing health and wellness plans to control obesity have long understood that the effectiveness of the program is contingent upon social norms (e.g., Walsh & Egdahl, 1989). Community-based rating is a feature of many public-private programs such as the NFIP's national flood insurance program, and more recently for insurers offering homeowners insurance in wildfire-prone communities participating in the NFPA's Firewise USA program. These mitigation efforts are based on the community's shared perception of risk, a perception that is not purely determined objectively, but is instead socially constructed. We argue that a community's perception of risk does not apply uniquely to the risk of contracting COVID-19 or having an adverse reaction to its vaccine, but also applies to numerous risks including the risk of hurricanes, flooding, drought, and wildfires. Simply put, cultures drives the community's perception of risk, which influences mitigation efforts, which affects the severity of risks, which in turn influences insurer pricing, underwriting, marketing, and product design. And at every stage, the level of influence of the norms created by the culture is driven by cultural tightness.

In short, we find that social norms matter to risk responses, and cultural tightness impacts how much social norms matter. Thus, in a broader level, we find that cultural tightness impacts risk responses. On the broadest level, our findings also highlight something that is often overlooked in risk management: culture matters to risk management practices. This implies that when a society depends on individual action to help manage society-wide risks, the society's cultural characteristics will have a large influence on the degree to which individuals will engage in actions that minimize the overall risk to the society. We believe that further research is warranted in this area, particularly as it relates to possible ways for leaders to implement effective risk management strategies.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

[9]One example that we think was partially effective during the COVID-19 vaccination case was an advertisement featuring several NBA Hall of Famers, with Julius "Dr. J" Erving saying in a voiceover that he was "never afraid to take the big shot… I'm getting vaccinated." This was humorous, did not look like it came from a corporation or government agency, and featured highly trusted influencers.

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